certain definite positions will tell us what substances are present. Now, in 1871 rings were seen, and they were very bright. In 1878 no ring whatever was seen. The question to be decided, then, was, Did this year's eclipse resemble in this respect the eclipse of 1871 or 1878? The result of the inquiry was that there were rings, but that they took time to see. This indicated a solar condition more resembling that presented in 1871 than in 1878, but stopping short of it.

Owing to these difficulties, hardly had Mr. Lockyer time to pass back to the telescope by means of which the spectrum of the corona was to be studied, when the clock showed that sixty-five seconds had elapsed, and Mr. Buchanan's "over" filled all with regret that the phenomenon, so rare and beautiful, and full of such precious knowledge, which each was doing his "level best" to secure, should be so ephemeral. So the caps were put on the cameras by Dr. Schuster and his assistant, Mr. Woods, lest the precious records which it was hoped might have been secured thould be spoiled by the first beam of the reappearing sun. It turned out, however, that so admirably had the eclipse been calculated, and so exactly had the French party hit upon the central line, that the totality really lasted 7 seconds more, that is, the full 72 seconds. The spectrum of the corona, therefore, was studied for a second or two under, perhaps, better conditions than had ever been present before, excepting during the memorable observation of Janssen in 1871. There were the red and green and blue lines stretching right across a wide field of view, and although no obvious dark lines were seen in the momentary glimpse, it was obvious that the spectrum was not truly a continuous one. There were variations of intensity here and there, and not the equal toning generally observed. So then ended the totality in one of the observatories. Dr. Schuster and his assistants at once proceeded to the extemporised dark room on board the steamer to develop the photographs, while those members of all the parties who had made telescopic or spectroscopic observations retired to the solitude of their tents to write down their results while they were still fresh in their minds.

Later on in the day there was a conference, at which the collective note, which I have already telegraphed to you, was drawn up and signed on behalf of the several expeditions. The observations were thought then, and are thought now, to have been a splendid success. The photographic results obtained by Capt. Abney's rapid plates have secured permanent records of the highest value, which largely increase our knowledge of the sun's atmosphere. They connect the spectrum of the sun with that of the stars in a most unmistakable manner; and, taken in connection with the observations of Lockyer and Trépied on the bright lines visible before totality—observations predicted a year ago in the teeth of received opinion—show that those who would explain solar phenomena in the light of terrestrial chemistry have their work cut out for them. But on this and on some other matters I may have something to say in a subsequent letter.

The Cairo Correspondent of the *Daily News* telegraphs on Monday:—

By order of the British Government, Sir E. Malet has officially thanked the Khedive for the great attention and services rendered to the Eclipse Expedition. The Khedive has returned a complimentary answer. No other Consul has yet thanked his Highness.

AURORÆ IN GREENLAND[1]

SINCE the publication of the researches on Auroræ by Baron Nordenskjöld, the study of this enigmatical phenomenon has acquired still more attraction for the student of the physics of the globe. We are glad, therefore, to notice the appearance of a new work on "Auroræ," published by the Danish Meteorological Institute, being a discussion, by M. Sophus Tromholt, of the fifteen years' observations (1865-1880) made by M. S. Kleinschmidt at Godthaab in Greenland.

The auroræ at Godthaab are seen, of course, almost exclusively in the southern part of the sky. "I do not remember," M. Kleinschmidt says, "to have seen during these last twenty-five years, more than a few times, any aurora in the north; the middle point of the aurora-arc is usually situated between due south and south-south-east, with small oscillations on both sides of this middle point. In all colonised parts of the western coast of Greenland, the auroræ are always seen towards the south; but it seems to me that at the southern extremity of this country, I have observed more intense auroræ extending throughout the whole of the sky." This observation fully confirms the conclusions of Baron Nordenskjöld, as will be seen from his map, which we reproduced (NATURE, vol. xxv. p. 371). Godthaab being situated in 64° 11′ N. lat., that is, in the third region of Nordenskjöld, the exterior circle of the glory must appear as a bow in the south, and the common, or interior one, as a luminous arc in the magnetic north, or, rather, as a light spread throughout the sky. Indeed, northern auroræ were seen at Godthaab only during twenty-five days, out of fifteen years, and their number was but forty in the morning hours, and sixteen in the evening. At Jacobshavn (69° 13′ N. lat.) 50 per cent. of all auroræ are seen towards the south east, 26 per cent. towards the east, and only 9·5 per cent. appear in that part of the sky which is comprised between north-west and north-east. At Upernivik (72° 47′ N. lat.) the disproportion is still greater, 74 per cent. of auroræ appearing between south-east and south, 14·5 towards the east, and only 4·8 per cent. between north and west. As to the frequency of the quiet arc-aurora (the "glory" of Nordenskjöld), as compared with that of the brilliant ray-auroræ, it is difficult to judge by the abstracts of observations published by M. Tromholt, inasmuch as the observer seems not to have attached great importance to this difference; but it results from what he says that the most frequent shape is that of a luminous arc "whose rays are diffused so that the luminous mass seems to be homogenous." The rays are often only pulsations in the arc itself. As to the fascinating and brilliant ray-auroræ, they are by far less frequent than the former; however—in accordance with Nordenskjöld's theory—they are not uncommon in this latitude. The height of the middle point of the arc is usually from 5° to 10° above the horizon. Feeble light, very much like twilight, is not uncommon, as well as a similar light spread throughout the sky. M. Kleinschmidt has also observed auroræ in the shape of "an immense column of smoke," consisting of more or less defined rays: "it nearly always appears in the same position, starting from a point between north-east and east-north-east, whence it crosses the zenith and reaches an opposite point of the horizon." The same was observed in the "common arc" by Nordenskjöld (NATURE, vol. xxv. p. 369, Fig. 5).

The number of auroræ extending beyond the zenith, or appearing in the northern part of the sky being anything but numerous, it is only with caution that we may admit the conclusion arrived at by M. Tromholt as to a periodicity in the oscillations of the "auroral belt;" but it is worthy of notice that his conclusion is the same as that arrived at by Weyprecht, namely, that "the auroral belt advances towards the south about the autumnal equinox, then moves towards the north, and reaches its most northern position about the winter solstice; thence it again moves towards the south, and occupies its most southern position about the spring equinox; after that it again returns towards the north." If confirmed by more extensive observations, this result would imply an

[1] "Om Nordlysets Perioder, efter Iakttagelser fra Godthaab i Grönland." Af Sophus Tromholt. (Publication of the Danish Meteorological Institute.) Copenhagen, 1882.

oscillation of Nordenskjöld's "glory" in dependence on the seasons. Another, diurnal oscillation, according to which the auroral belt would slowly advance towards the north (for Godthaab) during the night, seems very probable. It would explain—M. Tromholt says—the greater intensity of auroræ towards midnight, as well as the greater frequency of northern auroræ among those which were observed at Godthaab during the morning; but this last phenomenon, of course, might depend also upon some diurnal variation of the intensity of the "common arc." In any case, these conclusions are to be considered as provisory ones, and must be submitted to the further test of observations carried on at points more favourably situated than Godthaab for the study of these oscillations. Such is also the opinion of M. Tromholt himself.

Of course, the fifteen years' observations at Godthaab do not include a period of time sufficiently long for enabling us to deduce from them the laws of periodicity of auroræ. But still they allow of several interesting conclusions which may serve as a guidance for further researches. Thus, it appears from them—contrary to what was said as to the auroræ being more frequent during the most cloudy days—that the number of observed auroræ is directly proportionate to the brightness of the sky. This dependence appears not only for different years or months, but also for separate days. If all the days when auroræ were observed are classified according to their brightness, which is expressed by the figures 1 to 4, and the brightness compared with the average number of auroræ observed during the days thus classified, we see that while the quantity of clouds was 1·6, 1·7, 1·8, 1·8 ... 3·2, 3·3, 3·4, and 3·5, the average corresponding number of auroræ was 7·0, 7·0, 5·0, 5·0 ... 2·9, 2·7, 3·5, and 1·5, the decrease being altogether very regular, so as to leave little doubt as to the accuracy of the law.

The following data have some bearing on the $11\frac{1}{9}$ years' period of auroræ which was deduced from observations in more southern latitudes, and which is considered as depending upon the amount of solar spots. Reckoning the years from August to May, so as to comprise in each year all autumn, winter, and spring auroræ (during the bright nights of the summer they are not observable), the yearly number of auroræ during the years 1865-66 to 1879-80 is given by M. Tromholt as follows:—97, 112, 65, 84, 45, 61, 32, 47, 73, 97, 97, 104, 69, 100, and 75, that is, rather irregular. Nevertheless, it is easy to perceive in these figures a certain periodicity with three maxima corresponding to the years 1866-67, 1876-77, and 1878-79. By introducing a correction which depends upon the brightness of the sky, and reducing the observed number of auroræ to an average cloudiness, M. Tromholt finds another series which is more in accordance with the number of solar spots as given by Wolf. Both series for the years 1865-66 to 1879-80 (August to May), appear as follows:—

Number of auroræ, with correction for brightness of sky

86·2, 91·3, 67·4, 80·9, 51·7, 56·5, 32·0, 46·0, 78·4, 97·0, 95·0, 102·0, 73·0, 85·2, 83·3

Number of solar spots

23·5, 6·1, 18·3, 60·1, 107·0, 133·5, 98·6, 89·4, 51·7, 32·1, 11·6, 13·5, 6·8, 2·2, 16·3

It would seem from these two series, that instead of being proportionate to the number of solar spots, the number of auroræ is rather *inversely* proportionate to this number, the two maxima of auroræ corresponding with the two minima of solar spots, and the minimum of auroræ arriving one year later than the maximum of solar spots. The same appears still better from the observations at Stykkisholm in Iceland, which run through the years 1846-47 to 1872-73. Both curves for this place (auroræ and solar spots), although showing several irregularities, nevertheless display a marked connection between the two phenomena; both inflexions of the auroræ curve towards a maximum correspond very well with the minima of solar spots, and *vice versâ*. The result for Godthaab and Stykkisholm is thus the inverse of what was found in more southern latitudes; and, to explain this contradiction, the author admits that the "auroral belt" is subject in its oscillations to a period of about eleven years, during which it advances more towards the north at the time when the number of solar spots reaches a minimum, and returns back towards the south during the maximum period of solar spots.

As to the number of auroræ observed respectively during the evening and during the morning, the observations at Godthaab fully confirm the fact already noticed at other places, namely, that auroræ are more frequent during evening hours. But it still remains to investigate in how far this difference depends upon the hours of observation, the observer usually taking notice of nearly all auroræ which appear before midnight, and not noticing those which appear during the first six hours after midnight.

Such are the questions discussed in M. Tromholt's memoir. As will be seen, they are rather indicated than definitely solved; but we must be thankful to the author for having raised them, and express a hope that the observations of auroræ which are now made to such an extent in Norway and Greenland, may be extended to the polar parts of Siberia and North America; we earnestly hope that the Meteorological Commission of the Russian Geographical Society, which already has done so much useful work, will soon extend its network of observations over this new field, which becomes every day more and more important. P. K.

ILLUSTRATIONS OF NEW OR RARE ANIMALS IN THE ZOOLOGICAL SOCIETY'S LIVING COLLECTION[1]

VIII.

20. THE MULE DEER (*Cariacus macrotis*).—While the Virginian Deer (*Cariacus virginianus*) is widely distributed all over the continent of North America, it is necessary to go far to the west before we arrive within the limits of the range of the two other species of the same group—the Mule Deer (*C. macrotis*), and the Black-tail (*C. columbianus*). Of these western deer, the latter, of which the Zoological Society had living specimens some years ago,[2] is confined to a narrow strip of land along the Pacific coast. But the Mule Deer has a larger distribution, being found on both sides of the Rocky Mountains, and extending eastwards of the main range, far into the prairies of Missouri.

The Mule Deer was discovered by Lewis and Clarke during their expedition to the Rocky Mountains in 1804, on the Missouri River, in about 42° N.L., and was so named from the excessive development of the ears, which at once distinguishes it from its fellows. Its most natural home is the mountainous region which flanks the main range of North America on both sides, though, as already stated, it extends hundreds of miles into the great plains drained by the Mississippi and its affluents. It is also met with in Oregon and British Columbia, though rather superseded in numbers in this quarter by the Black-tailed Deer.

The antlers of the Mule Deer, which, as in most other deer, are borne only by the male, are of the same peculiar type as those of the Virginian Deer. All the normal tines have a posterior projection, and the beam, after casting off the basal snagg, curves gradually forward and inward, until the extremities remotely approach one another. The tines thus stand mostly upright when the head is carried in its usual position, but when the head

[1] Continued from vol. xxv. p. 610.

[2] See Wolf and Sclater "Zoological Sketches," vol. i. pl. 20, for figures of the Deer.